Outline of the Proposed Research Work Entitled

Study and Development of Real-Time Face Recognition Techniques

Synopsis

Submitted to

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

For the degree of

Doctor of Philosophy in computer science

Under

School of computational sciences

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Abstract:

Human face recognition have been an active research area for the last few decades. Especially, during the last five years, it has gained significant research attention from multiple domains like computer vision, machine learning and artificial intelligence due to its remarkable progress and broad social applications. The primary goal of any face recognition system is to recognize the human identity from the static images, video data, data-streams and the knowledge of the context in which these data components are being actively used.

Face recognition research in controlled environments has been proved to be very successful and obtain required targets for social applications, substantial challenges are still there for an uncontrolled environment where subjects are dynamic, variations are difficult to catch in machine perspective due to certain causes.

The pose is the most difficult recognition challenge especially when the subject is in an uncooperative environment like searching a spy in a public crowed, terrorist's protection on airport and finding thieves in big marts, etc.

Variable illumination or lightning effect is another major challenge for face recognition systems. Due to skin reflectance properties, multiple camera sensors, resolution effects and environmental conditions, illumination is totally uncontrolled for machine intelligence. Traditional approaches have their own limitations with varying illumination effects.

Face occlusion means hiding important facial features due to the presence of other objects like hate, helmet, sunglasses, hand, scarf, mask, etc. Occlusion is another critical factor that seriously affects the performance of face recognition technique.

Keywords Face recognition, Face identification, Artificial intelligence, Computer vision, visual surveillance

Introduction:

Facial recognition is the process of identifying or verifying the identity of a person using their face. It captures, analyzes, and compares patterns based on the person's facial details.

Face as a human identity spans over the centuries in human civilizations. It has been one of the most proactively studied topics in computer vision and machine learning research for more than five decades. Compared with other common biometrics such as iris, retina or fingerprint based identification, face recognition has the ability to uncover uncooperative subjects in a proficient manner. In recent years, a lot of successful research outcomes have been recorded for images in a controlled environment, but in an unconstrained environment like variable illumination and diverse pose, face recognition is still a complex and challenging problem.

Face recognition has been an active research area for the past few decades. Especially, during the last five years, it has emerged as one the most flourishing research topic among image processing, computer vision, machine learning, artificial intelligence and visual surveillance due to broad social, scientific, commercial applications. The primary goal of face recognition system is to recognize the human identity from the static images [196], video data [264] or from data-streams [183] including the knowledge of the context in which these data components are being actively used. Due to rapid progress in sensors and imaging technologies, the face recognition systems have been broadly used in many real-world applications. Specifically, human-computer interaction, human-robot interaction, person identification for security objectives, face as a mobile biometric recognition, law enforcement, voter identification, counter-terrorism, border control and immigration, daycare centers, social security, banking, e-commerce [93, 132] etc.

With a wide range of real-world applications, face recognition has received remarkable attention from both commercial stakeholders and research communities. There is an essential demand for robust face recognition algorithms that are highly capable of dealing with complex real-world situations.

Literature review

Since, face recognition has been a key research area for the last three decades by many research communities like machine learning, artificial intelligence, image processing, and computer vision. Methods proposed for face recognition belong to vast and diverse scientific domains and that is why it is difficult to draw a clear line that categorizes these approaches in a standard way. Also, the usage of hybrid models makes it difficult to categorize these approaches in standard branches for feature representation or classification. However, according to recent literature, present face recognition approaches as a clear and high-level categorization. Figure 1 shows the categorical distribution of face recognition approaches:

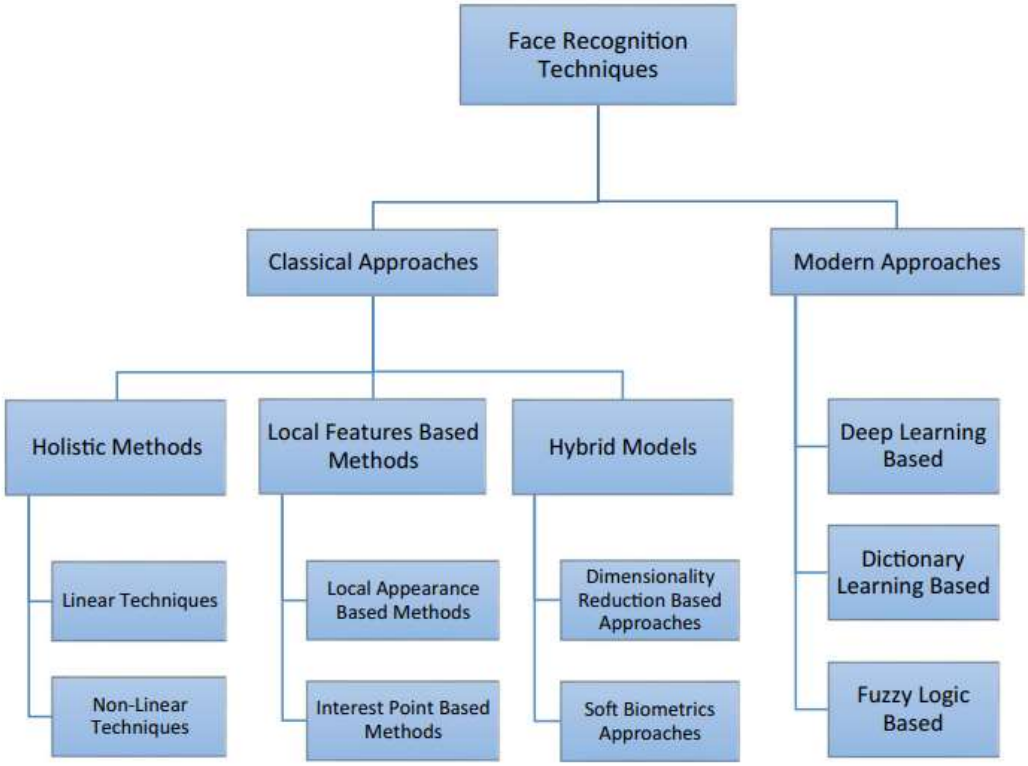

Figure 1:Categorical distribution of face recognition methodologies

1. Classical approaches

The research in face recognition has long historic roots such as in the 1950s psychology and 1960s in engineering literature [298]. These beginning concepts were derived from pattern recognition systems as discussed in an MIT Ph.D. thesis [210] by Lawrence Gilman.

1.1.Holistic methods

Holistic methods, also known as global features based methods, attempt to identify face using global characteristics, i.e., entire face representation is considered rather than individual components like mouth, eyes, and nose, etc. Turk et al. [250] with Eigenface, Kamran et al. [58] with Linear Discriminant Analysis (LDA), Zhao et al. [300] with Subspace Linear Discriminant Analysis (SLDA) and Bartlett et al. [21] with Independent Component Analysis (ICA) for face recognition. In the same era, Guo et al. [80].

1.2.Local features based methods

Local features based approaches first evaluate the input image to segregate distinctive facial regions like the mouth, nose, eyes, etc. and then figure out the geometric relationships among these facial points. A group of statistical pattern recognition techniques and graph matching methods are available to compare these features. Early days efforts for local features based face recognition includes: Kanade et al. [154] with linear feature matching scheme, Yuille et al. [282] with interest of the points-based features extraction method using deformable templates, Brunelli et al. [28] with geometric features based templates matching scheme and Leads et al. [133] with dynamic link architecture based Gabor filter utilization are most considerable in classical face recognition literature.

1.3.Hybrid methods

The third category in classical face recognition approaches is hybrid methods that use both local and holistic methods simultaneously. Hybridizing or mixing different approaches to obtain better results is a common research trend. Many researchers exploit hybrid models to take advantages of both local and global methods. The literature on hybrid face recognition approaches is quite vast and scattered in multiple disciplines and the key methods that we considered includes: Tolba et al. [246] with a combined classifier based on Radial Basis Function (RBF) and Learning Vector Quantization (LVQ), Huang et al. [102] with integration of holistic and feature analysis-based approach utilizing a Markov random field model and Wang et al. [256] with a biologically inspired features model and Local Binary Patterns (LBP).

2. Modern approaches

In recent years, there is an immense improvement due to machine learning-based algorithms and methodologies in a lot of social and scientific domains. We summarize the modern era of face recognition approaches as three subcategories i.e. deep learning-based methods, sparse or dictionary learning-based methods and fuzzy logic-based techniques. An overview and research contributions in these categories are presented in this section.

2.1.Deep learning based face recognition

It has been observed that deep neural networks have massive computational power for object recognition and it has revolutionized machine learning during the last few years. Researchers from all the fields including but not limited to social sciences and engineering to life sciences considering deep frameworks to hybridize their existing models and get radical results. Many researchers, especially in face recognition community [15, 232], affirms that it has remarkable computational power with outstanding accuracy and result oriented behavior.

Early face recognition applications as discussed in [230, 298] use ANN for large scale features representation. This idea ultimately leads towards maximization of hidden layers in a neural network. Each layer in a deep model is based on a kernel function with a defined optimization objective and its multilayer architecture [15] that made possible to extract features space in a generalized way. The ability to automatically learn from unlabeled data without any human involvement make it incredible for identification purpose. The use of deep belief network in 2006 [97], hybridizing different approaches by Sun et al. [231] and classification of ImageNet with CNN [129] are believed as key milestones, and it has opened a new generation of face recognition research in last few years.

Preprocessing and Deep Models: Since face alignment is one of the key preprocessing challenges among overall face recognition process. It aims to localize facial landmarks and predict face position in the input image. This is an open research problem for many decades. Shi et al. [223] address the problem by using deep regression model and gain a significant improvement in output results. The model contains a global layer that formulates the initial face shape and multiple local layers that iteratively update the shape estimated by global layer.

Design Invariants for Deep Model: Here, an important question is how to design a deep neural network for a particular face recognition system? Many researchers address this problem in different ways but a considerable effort has been done by Chen et al. [35]. Design principles for a deep convolutional neural network architecture have been discussed for unconstrained facial images both for static and video streaming data. It is illustrated that most of the times CNN architectures have to analyze millions of parameters that impose massive computational and memory overhead, so a balanced compromise between the cost and efficiency is required while designing a deep architecture. Positively, all critical aspects of face recognition system like face alignment, detection, association, and face verification have been discussed. Another considerable effort has been done by Hasanpour et al. [90].

Recent Developments: Kim et al. [127] show that transfer learning from a convolutional neural network on a 2D face images can better perform for 3D face identification. They use VGG face for initially 2D training and then add 3D data to enlarge the size of data which make CNN more robust for recognition. Additionally augmented 3D data is converted into a 2D depth map, isolated random points are separated from this depth map to simulate hard occlusions. Finally, a fine-tuning phase added to represent 3D face features from the previous layers. Lin et al. [151] present another novel idea based on clustering lightened deep model for large scale face identification to deal with Microsoft Challenge of recognizing one million celebrities (MS-Celeb-1M).

Table 1:Summary of Deep learning-based face recognition approaches

Article Ref.	Method	Backbone	Year	Overall summary	Dataset	Accuracy
Tang et al. [240]	Deep Hashing	CNN	2017	Deep Hashing based on Classification and Quantization errors (DHCQ).	YouTube	77.86%
Jiang et al. [111]	DFF	CNN	2018	Deep Face Features (DFF), for face alignment.	AFLW	95.28 %
Yin et al. [278]	Transfer Learning	Auto encoder	2018	Transfer learning based framework to deal with longtail data for a	LFW	98.83 %

				face recognition system		
Zhong et al. [304]	Deep CNN	CNN	2019	Visual methods utilized to explore face features by a deep network	VGGFace	75.90 %
Wu et al. [268]	IDICN	DCNN	2020	A deep network for multispectral face recognition	HK Polyu	99.76 %

Important of study:

As of today, face recognition is one of the most vibrant research areas among machine learning, artificial intelligence and pattern recognition communities. With a lot of social and scientific applications, it has an enormous impact on the upcoming digital society. Earlier, we have discussed a number of classical appearance-based approaches and numerous recent machine learning-based like deep learning, transfer learning and dictionary learning approaches for face recognition. The accuracy achieved by different researchers has been discussed on various data sets like MS-Celeb-1M, YALE, AT&T, AR, 3DMAD, GEORGIA, PubFig, and CMU-PIE, etc. Certain challenges have also been discussed such as computational cost reduction, illumination variations, viewpoint robustness, scale and rotation variations, 3D data acquisition, etc. Occlusion and background subtraction still have a lot of question marks for future research. In the end, by comparing various techniques we conclude that hybridizing soft bio-metrics with other existing face recognition methods can achieve remarkable success in this potential research area.

Objectives of the study:

The following is a list of the study's objectives:

- To explore various methods for facial recognition ,Gain knowledge and highlighting the contribution of AI against real time face recognition
- To create or improve and implement a new method or technique of real time face recognition.
- To evaluate and analysis the performance of the developing methods in order to clarify their efficiency and effectiveness in comparing them to some previous methods.

- To give recommendations and conclusion for future enhancement.

Methodology:

- Analyzing and evaluating the different existing modern real time face recognition techniques and algorithms.
- Design new efficient method for real time face recognition.
- Implement the proposed method on popular framework such as TensorFlow, Keras, PyTorch and training on the concerned
- Testing and validating the proposed work.

Schedule.

Year 1:

- Literature Survey.

Year 2:

- Theoretical analysis of the existing methods for real time face recognition techniques

Year 3:

- Design new method or technique of real time face recognition techniques
- Assessment of experimental results in terms of comparison.

Year 4:

- Interpretation of the experimental results.
- Preparation of final synopsis and thesis.
- Submission of synopsis and thesis.

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